

AMENDMENTS TO THE SPECIFICATION

Please substitute the following marked up paragraph(s) for the paragraph(s) now appearing in the currently filed specification:

[0001] The present invention is related to the following copending and commonly assigned United States patent applications: serial number ~~{30014517-1}~~ 10/033,003 entitled Method for Using Partitioning to Provide Capacity on Demand in Data Libraries, filed December 28, 2001; serial number ~~{30014516-1}~~ 10/033,010 entitled System and Method for Securing Fiber Channel Drive Access in a Partitioned Data Library, filed December 28, 2001; serial number ~~{30014515-1}~~ 10/034,888 entitled System and Method for Securing Drive Access to Data Storage Media Based On Medium Identifiers, filed December 28, 2001; serial number ~~{30014514-1}~~ 10/034,518 entitled System and Method for Securing Drive Access to Media Based On Medium Identification Numbers, filed December 28, 2001; serial number ~~{30014513-1}~~ 10/032,923 entitled System and Method for Peripheral Device Virtual Functionality Overlay, filed December 28, 2001; serial number ~~{30014512-1}~~ 10/032,662 entitled System and Method for Managing Access to Multiple Devices in a Partitioned Data Library, filed December 28, 2001; serial number ~~{30014511-1}~~ 10/033,009 entitled System and Method for Partitioning A Storage Area Network Associated Data Library Employing Element Addresses, filed December 28, 2001; ~~and~~ serial number ~~{30014510-1}~~ 10/034,691, entitled System and Method for Partitioning a Storage Area Network Associated Data Library, filed December 28, 2001 and issued as U.S. Pat. No. 6,715,031 on March 30, 2004; and serial number ~~{30008195-1}~~, 10/034,083 entitled System and Method for Managing a Moveable Media Library with Library Partitions, filed December 28, 2001[,] ; the disclosures of which are hereby incorporated herein by reference.

[0024] To configure the partitioning scheme, system 100 may comprise partitioning management controller 109 as disclosed in U.S. Patent Application Serial No. ~~{30014511-1}~~ 10/033,009 entitled "SYSTEM AND METHOD FOR PARTITIONING A STORAGE AREA NETWORK ASSOCIATED DATA LIBRARY EMPLOYING ELEMENT ADDRESSES." Partitioning management controller 109 may be communicatively coupled to a local area network (LAN) or other communication network. Partitioning management controller 109 may be coupled to FC-to-SCSI bridges 107a and 107b and external controller 108 via any suitable management bus such as the I2C (Inter-Integrated Circuit) bus.

Additionally, partitioning management controller 109 may comprise an embedded web server to enable a system administrator to configure or partition system 100 from a secure host system. The web server may provide a user interface to enable the system administrator to create a partition, delete a partition, assign resources to a partition, and define permissions applicable to a partition. Modifications to the partition scheme are preferably presented to a user graphically via the web server interface. Additionally, the web server may preferably enable a user to download a particular partition configuration to the user's system. The user may then reload the partition configuration at a later time. Additionally or alternatively to providing a web server, partitioning management controller 109 may receive commands (via a suitable network management protocol) to configure the partitioning scheme.

[0027] In a storage provider environment, the resources of system 100 are managed by a storage provider. The data storage capacity is sold as a service to customers of the storage provider. In such an environment, partitioning management controller 109 may implement additional functionality to provide instant capacity on demand as disclosed in U.S. Patent Application Serial No. ~~{30014510-1}~~ 10/034,691, issued as U.S. Pat. No. 6,715,031, entitled "SYSTEM AND METHOD FOR PARTITIONING A STORAGE AREA NETWORK ASSOCIATED DATA LIBRARY." In such an environment, a storage customer may pay for a given amount of storage capacity. When a customer requests extension or modification of the customer's partition, partitioning management controller 109 may verify that the customer has obtained a license for such additional library resources. For example, the customer may pay for a license that permits a maximum number of tape drives 103 and/or tape cartridges. Any partition extension request may be examined to determine whether the maximum number would be exceeded by performing the extension. Management controller 109 may either reject or enable the partition extension as appropriate. Moreover, it may be advantageous to cause certain resources to be reserved for future expansion by a specific customer. These resources may be disabled until the customer actually requires the resources and pays for their use.

[0031] In another embodiment, a greater degree of control may be applied to partitioning operations to ensure compatibility with software back-up operations. In an embodiment, the various components of tape library 101 are organized into levels (e.g., levels 106a and 106b shown in FIGURE 1). Each level comprises two media trays 104 and two

tape drives 103. The levels may then be assigned in a manner that is compatible with other commercially-available tape libraries. For example, Hewlett-Packard Company ~~SURESTORE 1/9~~ SURESTORE 1/9™ tape library utilizes nine tape slots. System 100 may be configured such that level 106a is made to appear to a host system or host systems as comprising at least two Hewlett-Packard Company ~~SURESTORE 1/9~~ SURESTORE 1/9™ tape libraries. To ensure compatibility with software back-up applications that utilize ~~SURESTORE 1/9~~ SURESTORE 1/9™ tape libraries, one partition should comprise the resources associated with the “left” side of level 106a (i.e., media tray 104a and tape drive 103a). The other partition should comprise the resources associated with the “right” side of level 106a (i.e., media tray 104b and tape drive 103b). By assigning resources in this manner, partitions will not share the same trays or drives. Accordingly, conflicts in commands will be reduced. Commands to each partition will only need to be queued until the robotics subsystem completes various mechanical operations. Commands need not be delayed due to data transfers to and from the tape cartridges.

[0032] Similar partitioning schemes may be utilized to cause partitions to emulate other tape libraries. For example, an entire level (e.g., level 106b) may be allocated to one partition to emulate the operations of HP ~~SURESTORE 2/20~~ SURESTORE 2/20™ (a tape library that includes two tape drives and twenty tape cartridges).

[0034] It shall be appreciated that the partitioning scheme may be configured to emulate at least two different tape library devices. For example, external controller 108 may be configured such that logical unit (LUN) 0 emulates a ~~SURESTORE 1/9~~ SURESTORE 1/9™ while LUN 1 emulates a ~~SURESTORE 2/20~~ SURESTORE 2/20™. A portion of level 106a may be allocated to the partition associated with emulation of the ~~SURESTORE 1/9~~ SURESTORE 1/9™ device. Library resources associated with level 106b may be allocated to the partition associated with emulation of the ~~SURESTORE 2/20~~ SURESTORE 2/20™. Additionally, external controller 108 preferably responds appropriately to SCSI inquiry commands addressed to each LUN. For LUN 0, external controller 108 may return the vendor ID, product ID, firmware revision, and vendor specific information defined by the ~~SURESTORE 1/9~~ SURESTORE 1/9™ device. Likewise, for LUN 1, external controller 108 may return the vendor ID, product ID, firmware revision, and vendor specific information defined by the ~~SURESTORE 2/20~~ SURESTORE 2/20™ device.

[0035] The user interface associated with partitioning management controller 109 may be utilized to control access to various partitions. For example, permissions table 301 may be created via the user interface. Permissions table 301 lists the authorized host systems for each of partitions 1, 2, 3, and 4. The authorized host systems are identified by Fibre Channel World Wide Name (WWNs) (e.g. WWN-1, WWN-2, WWN-3, WWN-4, WWN-5 and WWN-6, in FIGURE 3). Other communication protocol addresses or identifiers may be utilized in combination with or in lieu thereof. Permissions table 301 may be stored in non-volatile memory (e.g., EEPROM) in a location that is accessible to partitioning management controller 109.

[0037] External controller 108 preferably utilizes the configuration information received from partitioning management controller 109 to virtualize or emulate multiple instances of internal controller 102 as disclosed in U.S. Patent Application Serial No. [30014511-1] 10/033,009 entitled "SYSTEM AND METHOD FOR PARTITIONING A STORAGE AREA NETWORK ASSOCIATED DATA LIBRARY EMPLOYING ELEMENT ADDRESSES." As previously noted, system resource table 20 of the illustrative embodiment defines four partitions. Accordingly, external controller 108 may associate the four LUNs (0, 1, 2, and 3) with the respective partitions (e.g., LUN 0 corresponds to partition 1, LUN 1 corresponds to partition 2, LUN 2 corresponds to partition 3, and LUN 3 corresponds to partition 4). External controller 108 may be operable to process a command active on each individual LUN (external controller 108 may properly support disconnects). Additionally, external controller 108 may be operable to maintain the state of each "virtual" controller associated with each LUN to, for example, respond to various commands including Test Unit Ready and Request Sense, Mode pages, Log pages, and the like.

[0048] SAN fabric 401 provides a communication fabric to facilitate communication among system 100, storage devices 402-1 and 402-2, and host systems 403-1 through 403-4. SAN fabric 401 is typically implemented utilizing a Fibre Channel architecture. Fibre Channel is typically utilized due to the simplicity of its communication path, i.e., Fibre Channel utilizes a serial communication scheme. Additionally, Fibre Channel provides data communication at relatively high rates (e.g., 1064 Mbps) over either copper and/or optical fiber cables. Data communication rates may over Fibre Channel media may increase in accordance with further technological developments. Copper cables are generally

utilized when various storage devices 402 are separated from host systems 403-1 through 403-4 by intra-cabinet connections. Optical cables may support separation distances up to 500 meters from a device to a hub (a Fibre Channel interconnection unit within SAN fabric 401) and up to 10 kilometers between hubs. Fibre Channel further utilizes various communication topologies such as point-to-point, arbitrated loop, and star topologies. Fibre Channel also encapsulates or supports various communication protocols such as SCSI and Internet Protocol (IP) protocols. Devices that do not support Fibre Channel can be coupled to a Fibre Channel fabric via a bridge device. Specifically, numerous commercially-available bridge devices (such as Hewlett-Packard Company ~~SURESTORE SCSI BRIDGE FC 4/1~~ SURESTORE SCSI BRIDGE FC 4/1™) enable a SCSI device to be deployed on a SAN that employs a Fibre Channel fabric. Although Fibre Channel is typically utilized for SAN fabric 401, other communication mechanisms may be utilized. For example, it is frequently appropriate to perform remote mirroring operations to redundantly store mission-critical data at remote locations. For such operations, asynchronous transfer mode (ATM) network elements or leased-lines (T-1, OC-12, and/or the like) may be employed.

[0051] FC-to-SCSI bridges 107a and 107b preferably restrict access to system 100 according to the partitioning scheme. FC-to-SCSI bridges 107a and 107b may be implemented according to the bridging embodiments disclosed in U.S. Patent Serial No. ~~[30014512-1]~~ 10/032,662 entitled "SYSTEM AND METHOD FOR MANAGING ACCESS TO MULTIPLE DEVICES IN A PARTITIONED DATA LIBRARY." As previously noted, FC-to-SCSI bridges 107a and 107b receive authorized host information from partitioning management controller 109 by receiving WWNs associated with authorized host systems. It shall be appreciated that Fibre Channel messages are addressed with source IDs and not WWNs. Accordingly, FC-to-SCSI bridges 107a and 107b preferably maintain a source ID-to-WWN table. When a SCSI command is received by one of FC-to-SCSI bridges 107a and 107b, the bridge determines the source ID from the FC message. A table look-up is preferably performed to determine the originating host system WWN. The respective bridge utilizes the information received from partitioning management controller 109 to determine whether the originating host system is authorized to access the device associated with the command. If it is authorized, the command is passed to either external controller 108 or one of tape drives 103a through 103d.

[0054] As described in greater detail in U.S. Patent Serial No. ~~[30014512-1]~~ 10/032,662 entitled "SYSTEM AND METHOD FOR MANAGING ACCESS TO MULTIPLE DEVICES IN A PARTITIONED DATA LIBRARY," FC-to-SCSI bridges 107a and 107b may perform LUN renumbering. The view of the LUNs behind FC-to-SCSI bridges 107a and 107b may vary on a per-host system basis. For example, host system 403-1 may only be allowed access to the first partition emulated by external controller 108. Accordingly, FC-to-SCSI bridges 107b may renumber the LUNs visible to host system 403-1 so that only one LUN is associated with a library controller device. Accordingly, resources associated with other partitions may be hidden from host system 403-1. Additionally, FC-to-SCSI bridges 107a and 107b may preferably perform LUN renumbering such that each host system 403-1 through 403-4 sees a continuous series of LUNs on each SCSI bus with each series beginning with 0. Specifically, this process facilitates compatibility with various operating systems.

[0057] Accordingly, FC-to-SCSI bridges 107a and 107b preferably implement data mover functionality. As described in greater detail in U.S. Patent Application Serial No. ~~[30014513-1]~~ 10/032,923 entitled "SYSTEM AND METHOD FOR PERIPHERAL DEVICE VIRTUAL FUNCTIONALITY OVERLAY," FC-to-SCSI bridges 107a and 107b may respond to peripheral-to-peripheral data mover commands. For example, the data movers may be implemented to be addressed as separate entities (e.g., Fibre Channel LUNs). If the data movers are addressed by separate Fibre Channel LUNs, the data movers should be added to respective partitions to enable their use by host systems 403-1 through 403-4. respective partitions to enable their use by host systems 403-1 through 403-4. By adding the data movers to partitions, the security of the partitioning scheme may be maintained.